EFFECTS OF MIDSTORY REDUCTION AND THINNING IN RED-COCKADED WOODPECKER CAVITY TREE CLUSTERS

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The red-cockaded woodpecker's (*Picoides borealis*) preference for open pine forest is well known (U.S. Fish and Wildl. Serv. 1985). Encroachment of hardwood midstory within red-cockaded woodpecker clusters (colonies, aggregations of cavity trees used by groups of woodpeckers, see Walters et al. 1988) is believed to cause cluster abandonment (Hopkins and Lynn 1971, Van Balen and Doerr 1978, Locke et al. 1983, Hovis and Labisky 1985). Hardwood midstory encroachment has been statistically correlated to severe population declines of red-cockaded woodpeckers in Texas (Conner and Rudolph 1989).

Historically, wildfire ignited by lightning or

people during the growing season maintained the open, mature pine forest that red-cockaded woodpeckers prefer (Jackson et al. 1986). Management during the past decade has used winter fire as a primary method to reduce midstory, a method that is rather ineffective in the reduction of an established hardwood midstory (Brender and Cooper 1968, Langdon 1981, Conner and Rudolph 1989).

As a result of recent population declines (Jackson 1980; Baker 1982, 1983; Carter et al. 1983; Walters et al. 1988; Costa and Escano 1989) and because excessive hardwood midstory has been identified as a major cause of declines (Conner and Rudolph 1989), an intensive effort was begun on southern national forests to remove midstory from cluster areas. Although experts agree on the need to reduce hardwood midstory within cluster areas, con-

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cern exists on how rapidly midstory should be removed (Conner 1989). Drastic and sudden removal of midstory may cause red-cockaded woodpeckers to abandon clusters. Cluster abandonment following sudden midstory removal during the breeding season has been noted (Jackson 1990). Conner (1989) suggested that hexazinone injection would reduce unwanted hardwood midstory and cause a slow change in vegetative structure. Our objective was to evaluate the effect of sudden and extensive midstory removal and thinning on red-cockaded woodpecker cluster status in 3 national forests in eastern Texas.

METHODS

The study was conducted on the Angelina (ANF), Davy Crockett (DCNF), and Sabine (SNF) National Forests in eastern Texas. The activity status (active vs. inactive) of all known red-cockaded woodpecker clusters was determined in March and April on the 3 national forests in 1988 (pretreatment) and 1989 (post-treatment) (Conner and Rudolph 1989). Clusters were judged active if bark at resin wells excavated by red-cockaded woodpeckers was red, indicating recent pecking (see Jackson 1977, 1978). Breeding success (nestlings heard in the cavity) was determined by weekly visits to clusters from April to July in 1988 and 1989 on the ANF.

From late summer to early winter 1988, sudden and extensive midstory removal was performed in 16 active clusters (ANF = 8, DCNF = 2, SNF = 6) as a part of National Forest management of cluster habitat. Midstory and understory in the entire cluster area, including the 61-m buffer zone around the cluster, was completely removed. Prior to treatment on the SNF and DCNF, the hardwood midstory and understory were so extensive (about 4 to 5 m²/ha of midstory basal area) that visibility was limited to 15 m. Midstory was less dense on the ANF (3 m²/ha) because of herbicide injection 4 years prior (Conner 1989). On the SNF chainsaws were used to remove midstory and some pine basal area. On the ANF the midstory and understory trees were machine-ground into a mulch no higher than 20 cm above the ground. The same type of machine was used for midstory removal in 2 clusters on the DCNF. There was no measurable midstory basal area remaining in the 16 active clusters post-treatment.

Pines were thinned in 11 different clusters on the DCNF in 1988 reducing basal area from about 20 m²/ha to 14 m²/ha. During thinning operations, most midstory trees within the cluster areas were knocked down to within 2 m of the ground by logging equipment (skidders). Midstory and understory removal in these 11 clusters was not complete and must be evaluated

separately from the 16 clusters that received complete midstory removal.

Forest Service personnel selected which active clusters received midstory reduction and thinning. Midstory reduction was assigned primarily to those active clusters in each forest with the highest midstory basal areas. Financial and logistic constraints prevented treatment of all clusters in a single year; at present (1990), untreated clusters have either received or are currently scheduled for midstory removal. We used the remaining untreated active clusters (1988) on each forest as an experimental control (ANF = 11, DCNF = 15, SNF = 5). Midstory basal area in control clusters was approximately 1.5 m²/ha throughout the duration of the study. All active clusters on the DCNF were located in loblolly (*Pinus taeda*)/shortleaf (*P. echinata*) pine type. Of the treated clusters on the ANF and SNF, 13 were in loblolly/shortleaf timber type and 1 cluster was in longleaf pine (*P. palustris*). Fifteen of the untreated, active control clusters on the ANF and SNF were in longleaf pine and 1 was in loblolly/shortleaf pine habitat. A Chi-square analysis ($\alpha = 0.05$) was used to test the hypothesis that abandonment was equal in treated and untreated active clusters.

Ideally, untreated active control clusters should have been in the loblolly/shortleaf pine type. Only 1 untreated cluster was available in that habitat, necessitating use of clusters in longleaf pine. To compensate for this and to evaluate the effects of midstory treatment on abandonment rates, we calculated a cluster abandonment rate for loblolly/shortleaf clusters on the ANF from 1983 to the 1988 nesting season.

RESULTS AND DISCUSSION

Only 1 of 16 active clusters was abandoned on the 3 national forests that received sudden and extensive midstory removal. This cluster was located on the northwestern tip of the SNF and was more than 25 km from any other active cluster. Two years prior to treatment (1987 and 1988) only a single red-cockaded woodpecker was using the cluster. We strongly suspect that isolation was the primary cause of the inactivation of this cluster. Death of the lone woodpecker most likely caused inactivation rather than abandonment. None of the 31 untreated active clusters were abandoned. Inactivation of treated and control clusters did not differ ($\chi^2 = 0.027$, 1 df, $P = 0.89$). Previously, cluster inactivation in loblolly/shortleaf on the ANF had been 6% per year (Conner and Rudolph 1989). The inactivation rate of treated clusters during our study was 6.3% (1

of 16). Thus, sudden midstory removal did not increase the inactivation rate substantially above the historic rate on the ANF. Because the 6.3% loss of active treated clusters was likely the result of isolation, the inactivation rate might have been higher had the 16 clusters not been treated.

All 11 active clusters that were thinned on the DCNF were still active 1 month after the pine basal area thinning. Two months posttreatment, 1 thinned cluster was abandoned, but was active again when checked in March 1989 prior to the breeding season. This cluster was occupied by a single male red-cockaded woodpecker and was 1 of 2 clusters that were isolated (>20 km) from the main portion of the DCNF population. None of the 15 unthinned clusters were abandoned. Thinned clusters were not abandoned at a higher frequency than unthinned clusters ($\chi^2 = 0.04$, 1 df, $P = 0.88$).

Sudden midstory removal did not negatively affect red-cockaded woodpecker breeding success on the ANF. Six of 8 active clusters produced young in 1988, and 5 of 8 produced young during the breeding season following midstory removal. Nine of 11 control clusters produced young in 1988, and 8 of the 11 produced young in 1989. Breeding success was not significantly different between treated and control clusters ($\chi^2 = 0.007$, 1 df, $P > 0.94$).

Our untreated control areas did not have a higher abandonment rate than areas with complete midstory removal. Abandonment might have been higher in the control areas had midstory basal area been comparable with that of the treated clusters prior to treatment. Reasons why an extensive hardwood midstory causes cluster abandonment remain obscure. Cluster abandonment that occurs as a result of excessive hardwood midstory is probably a slow process. Midstory may increase competitor populations, causing increased competition for nest and roost cavities. Extensive hardwood midstory in the cluster areas may reduce the quality of foraging habitat close to the nest tree below

that needed to provide sufficient food for the young. Also, red-cockaded woodpeckers may have an innate avoidance of extensive midstory as a result of their evolution in an open pine forest ecosystem. Because our study only evaluated the short-term response to sudden midstory removal we cannot speculate on long-term benefits that may include a reduction of competitors and an enhancement of foraging habitat quality. Clearly, these are topics for future studies.

Jackson (1990) suggested that sudden vegetation removal during the nesting season was a possible cause for the abandonment he observed. Our results indicate that neither sudden and extensive midstory removal nor thinning, applied during the nonbreeding season, had an immediate negative effect on cluster occupancy. After the sudden alteration "shock," if any, has passed, we assume that treated clusters will be more attractive to red-cockaded woodpeckers than clusters with extensive hardwood midstory. The abundance of literature indicating the negative effect of an extensive hardwood midstory in cluster areas on red-cockaded woodpeckers (Hopkins and Lynn 1971, Van Balen and Doerr 1978, Locke et al. 1983, Hovis and Labisky 1985, and Conner and Rudolph 1989), combined with our finding of no short-term detrimental effect of sudden midstory removal, strongly indicates that hardwood midstory removal during the nonbreeding season should continue.

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